FULL DEPTH PRECAST CONCRETE DECK PANEL MANUAL

Refer to Utah Department of Transportation (UDOT)
Specification 03339 - Full Depth Concrete Deck Precast Panel

TABLE OF CONTENTS

Section 1

GENERAL INFORMATION

The purpose of this manual is to provide guidance with the design and detailing of Full Depth Precast Concrete Deck Panels using either mild or prestressed reinforcement in accordance with AASHTO LRFD Bridge Design Specifications except as noted otherwise.

The Precast (Prestressed) Concrete Panel details sheet will normally contain, but is not limited to, the following listed details:

- Plan View
- Typical Transverse Section
- Prestressing and/or Post-tensioning details
- Lifting details
- Transverse Joint Details
- Bar Details
- Table of Estimated Quantities

Nomenclature: The use of the terms 'Longitudinally' and 'Transverse' in this document and the guideline drawings will be in reference to the bridge direction unless otherwise noted.

Show the following dimensions on the Precast Prestressed Concrete Panel Details Sheet as listed below:

Structural dimensions and deflections. In the plan view, all structural dimensions in feet and inches to the nearest 1/8". Deflections shown in the dead load deflection diagram in decimal feet to the nearest 0.01'. All other views and details in feet and inches to the nearest 1/8".

Reinforcing steel. Reinforcement dimensions and locations in all views, including bar details, will normally be in feet and inches to the nearest 1/4". All measurements are to the centerline of the reinforcements.

Cover. Cover for the top panel reinforcing is 2-1/2" clear cover after 1/4" maximum grinding allowance and bottom panel reinforcing is 1" clear cover. Transverse bars have 2" end cover and longitudinal bars have 2" end cover.

Angles. In degrees, minutes, seconds to the nearest whole second, if such precision is available.

References. *Designer will verify that all requirements of the current AASHTO LRFD Bridge Design Specifications and current interim provisions Sections 5 and 9 are satisfied and properly detailed in any documents intended or provided for construction.*

Section 2

PRECAST CONCRETE PANEL SHEETS

These sheets are included to provide an example of the drafting layout of a typical Precast Concrete Panel Sheet. See the various sections of this chapter for directions on drawing particular details.

Example – Precast Panel Sheet

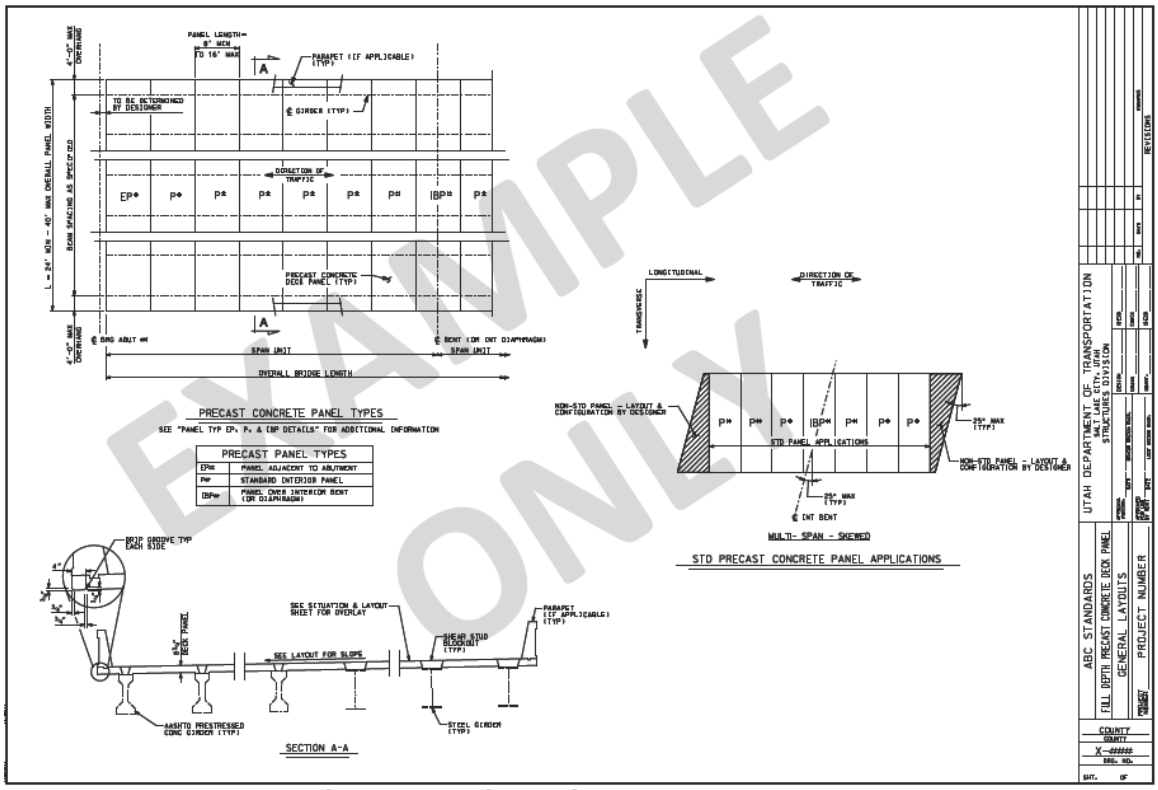

Figure 1 - Deck Panels on Concrete Beams

Section 3

SHEET CHECKLIST

Plan View

Accurate, measurable detail, with exceptions to enhance clarity

1. Label and locate the control line at transverse and skewed ends of panel (matching the terminology on the layout, such as reference line, centerline, or profile grade line).
2. Reference control dimensions at the working point (usually the intersection of the control line and the centerlines of bents and at the ends of the panel).
3. Overall panel length and individual span lengths dimensioned along the control line (and along panel edges if different).
4. Transverse widths of panel dimensioned, including overall, roadway, face of rail, curb, and median widths, and working point locations at the beginning of the panel.
5. Beam lines located and numbered.
6. Skew angles.
7. Label joint locations and type:
    a. Welded Tie
    b. Shear Keyway
    c. Longitudinal Post-Tensioning (LPT)
8. Panel reinforcing detailed, spacing dimensioned, and end cover shown.
9. Show abutment numbers and/or bent number.
10. Design Data.

Typical Transverse Section

Accurate, measurable detail, with exceptions to enhance clarity

1. Control line located both horizontally and vertically (note that more than one control line may be required).
2. Panel widths dimensioned (including overall, roadway, face of rail, offset from control line, etc.).
3. Show typical panel section reinforcing.
4. Reinforcing cover and panel thickness (interior and overhang).
5. Section depths (using table if required).
6. Beam spacing and identification.
7. Crown or roadway slope.
8. Spacing for reinforcement.
9. Spacing for longitudinal shear connectors.
10. Thin Bonded Polymer Overlay information or other approved overlay.
11. Future wearing surface information.
12. Post-tensioning shown for typical panel section.

Other Details

Accurate, measurable details, with exceptions to enhance clarity

1. Bar details, if applicable.
2. Joint details, if applicable.
3. Tendon confinement, if applicable.
4. Parapet attachment.
5. Tables of quantities.
6. General notes (including, but not limited to, design criteria, loading, class of concrete, epoxy coating or galvanization, and cross references to various standard sheets).
7. Title block, information block, and Engineer's seal.

Final Checks

1. Comply with UDOT CADD Detailing Standards.
2. Check all details and dimensions against substructure to ensure the details are not in conflict.
3. Double check bars in various details against the bars shown in the bar table.
4. Make sure that bridge drains and/or bridge lighting brackets are located correctly on the layout, when applicable.
5. Ensure that the name and number of the bridge is same on all detail sheets (including layout).
6. Initial the sheet after back-checking corrected details.

Section 4

CONDITIONS AND ORIENTATIONS

Precast Concrete Panel Conditions and Orientations.

Use the full depth panels and details for bridge deck replacement, bridge widening, and new construction that adhere to the panel parameters below. For situations that fall outside of the limits and parameters shown below, the designer may use this manual, specifications, and standard drawings as guidelines for the design and detail Non-Standard Panels for job specific conditions.

Panel parameters are as follows:

- AASHTO HL-93 Loading
- 35-psf Future wearing surface, in additional to overlay
- 8-3/4” – normal minimum panel thickness to allow for 1/4" grinding thus creating an 8-1/2” nominal panel thickness
- 1/2" Thin Bonded Polymer Overlay
- Panel (Bridge) Transverse Width
  - 24’-0” Minimum
  - 40’-0” Maximum
- Panel Longitudinal Length
  - 8’-0” Minimum*
  - 16’-0” Maximum
- 1’-0” Minimum & 4’-0” - Maximum Overhang
  - Zero overhang is allowed for closure pours, 6" minimum bearing
- Up to 10’-0” – Beam Spacing for Precast Panels
- 8’-0” to 12’-0” – Beam Spacing for Prestressed Panels
- Minimum 4 lifting devices/locations per panel
- Minimum 2 leveling devices per beam/girder
- Skews up to 25 degrees

* Non-Standard Panels under 8’ will use only mild-reinforcement.

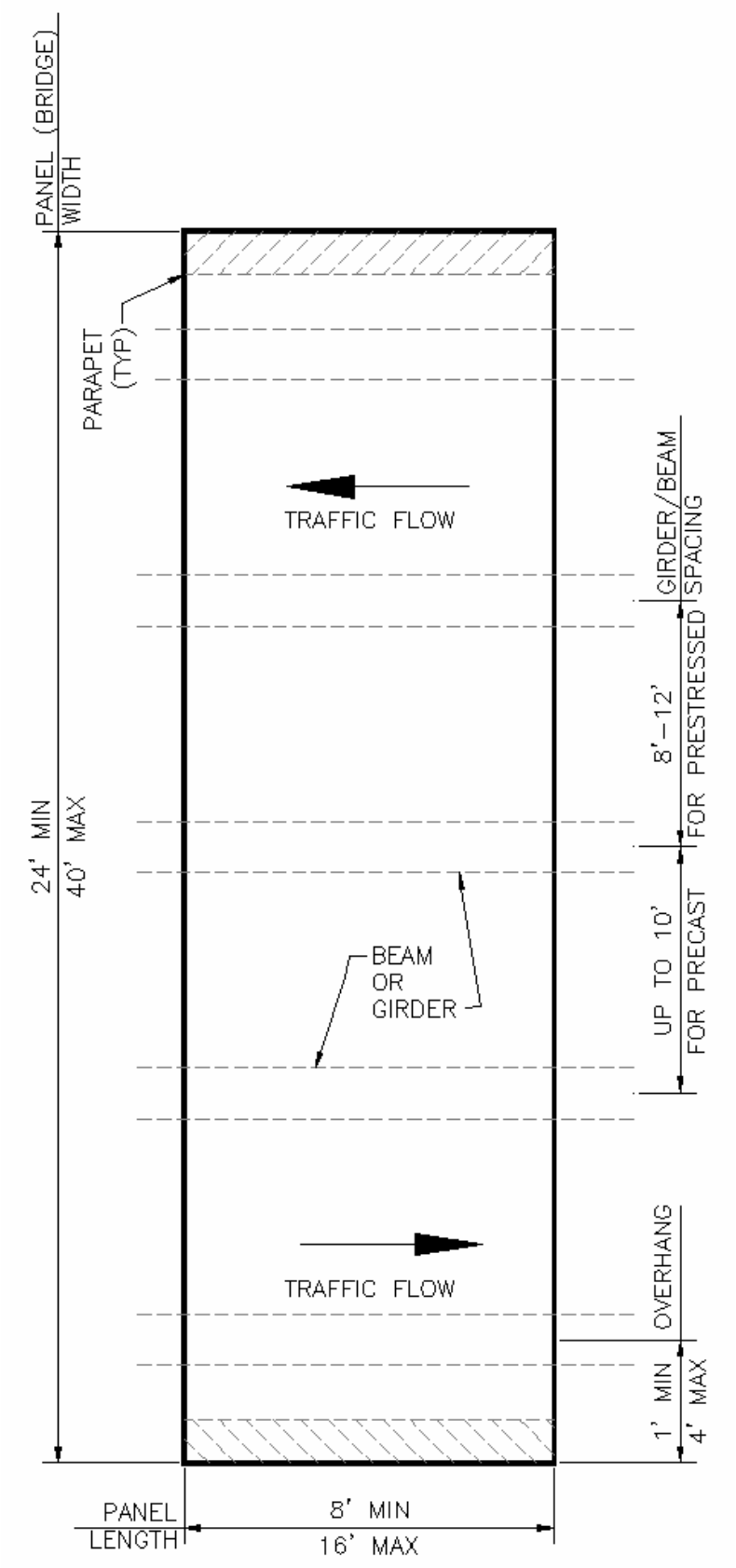

Figure 2 - Panel Dimensions

Skewed Bridges – Non-Standard Panels

This manual and associated specification and drawings serve as a guideline only for the design of the skewed panels. The full depth precast concrete deck panels are to be orthogonal to the supporting beams or girders. Designer will design and detail the resulting trapezoidal panel due to the bridge skew.

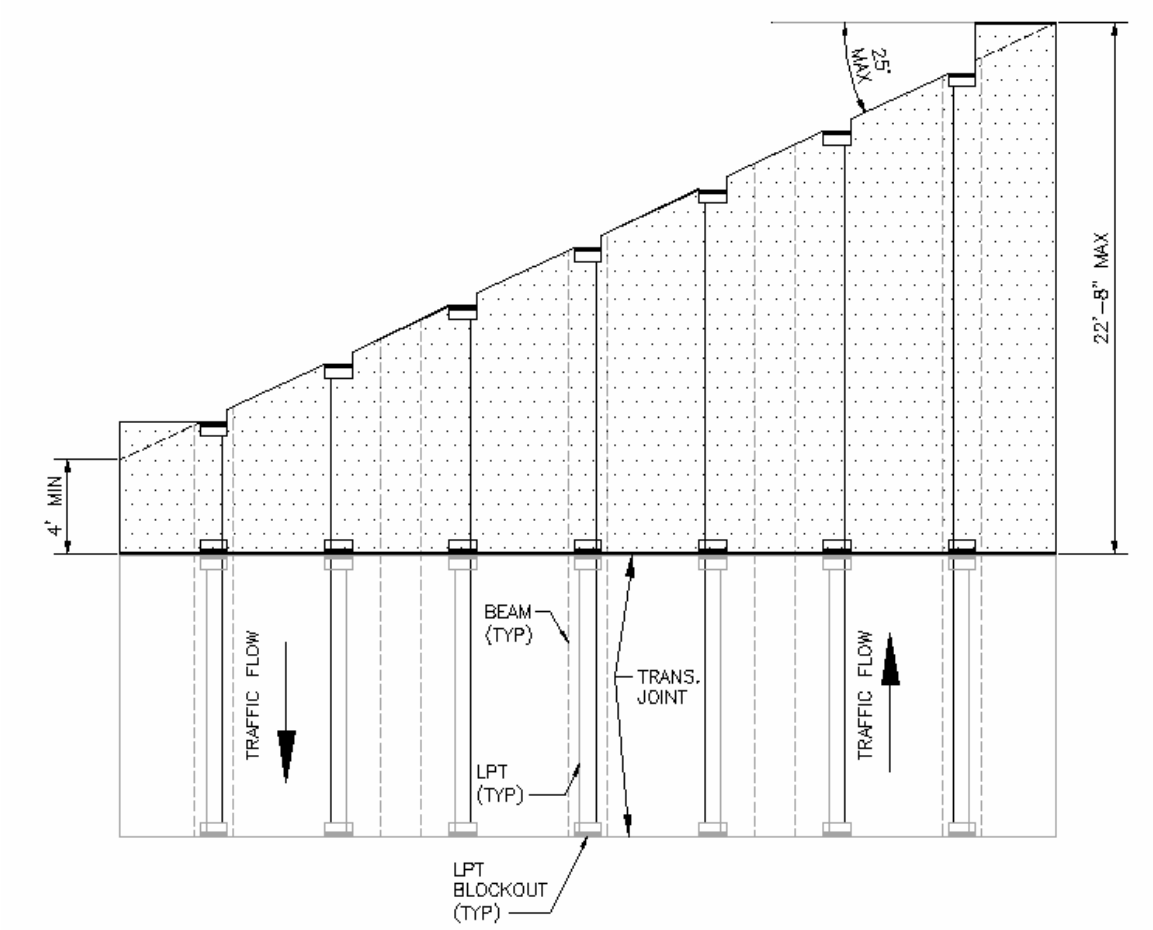

Figure 3 - Skewed Panel with LPT Joint Connection

Skewed panel parameters and limitations:

- The panel will have four sides as shown in plan with a minimum dimension of 4'-0".
- The maximum skew will be 25 degrees.
- The maximum weight of the panel will be 60 kips.
- Make longitudinal post tensioning blockouts parallel to strand and traffic.

Section 5

BEAM HAUNCH

Beam Haunch Details

The purpose of a beam haunch is to absorb the beam camber without intrusion of the beam into the bottom of the slab at centerline of bearing or at mid-span. This allows a uniform slab thickness. Use 1/2" minimum at the edge of the beam at midspan to accommodate the bedding strips for prestressed concrete panels. Regardless of calculated value, the absolute minimum haunch at centerline of bearing will be 1". (Increase in 1/4" increments).Reinforce haunch if the height of the beam haunch concrete is greater than 3".

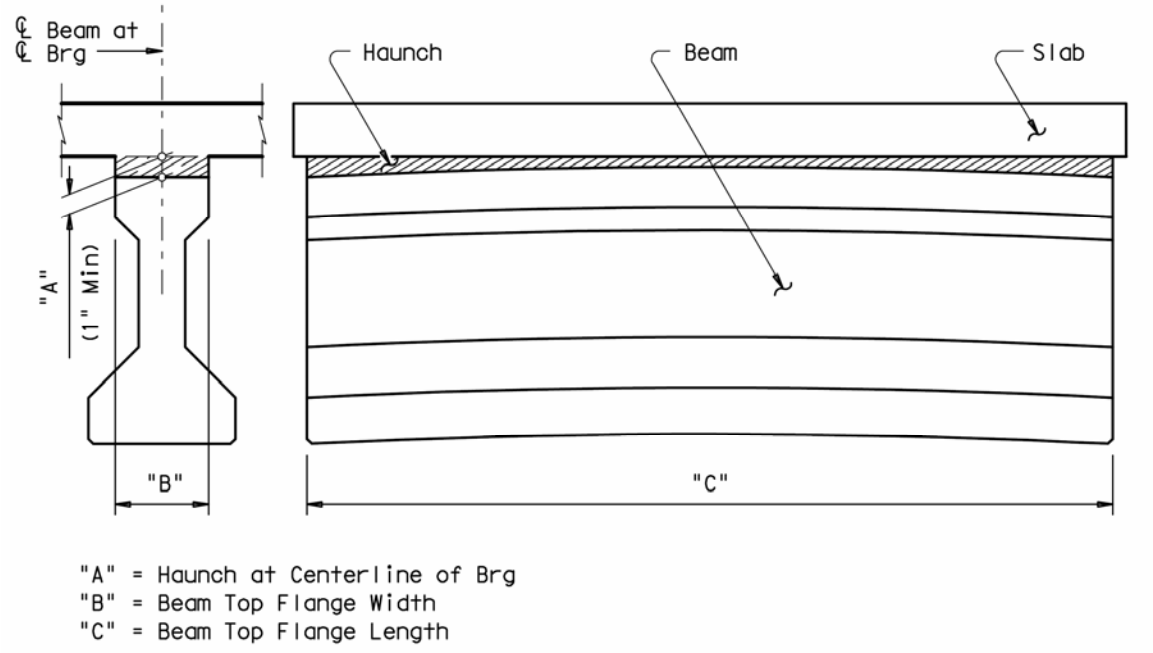

Figure 4 - Haunch Details

Section 6

TYPICAL MILD REINFORCING

Mild Reinforcement

Coat all mild reinforcement per UDOT Specification 03211 Reinforcing Steel and Welded Wire.

Reinforcement will not have lap splices within the panel. If splicing is required, specify and detail mechanical couplers on the plans. Couplers will develop a minimum of 125% of the minimum yield strength of the attached reinforcing bars. Use lap splices in closure pours but mechanical couples are encouraged. Do not weld reinforcement.

All top transverse reinforcement will have a standard 180-degree anchorage hook at each end.

Parapet Reinforcement

Designer will verify parapet reinforcement shown in the plans. Cast parapet connection reinforcement into panel.

The use of precast reinforcement mechanical couplers is acceptable provided the coupler meets AASHTO LRFD 5.5.3.4 Welded or Mechanical Splices of Reinforcement.

For parapet reinforcement, place in accordance with the plan, see the Parapet Details sheet. Do not drill and grout of parapet connection reinforcement into deck panel.

Precast Concrete Panel
Recommended Bar Sizes and Maximum Spacing

The information in this section shows typical precast concrete panel reinforcing and its placement. The reinforcement sizes, bends, and locations may be different from that given due to design requirements. Place all reinforcement in two layers. See standard drawings for reinforcement sizes and typical spacing.

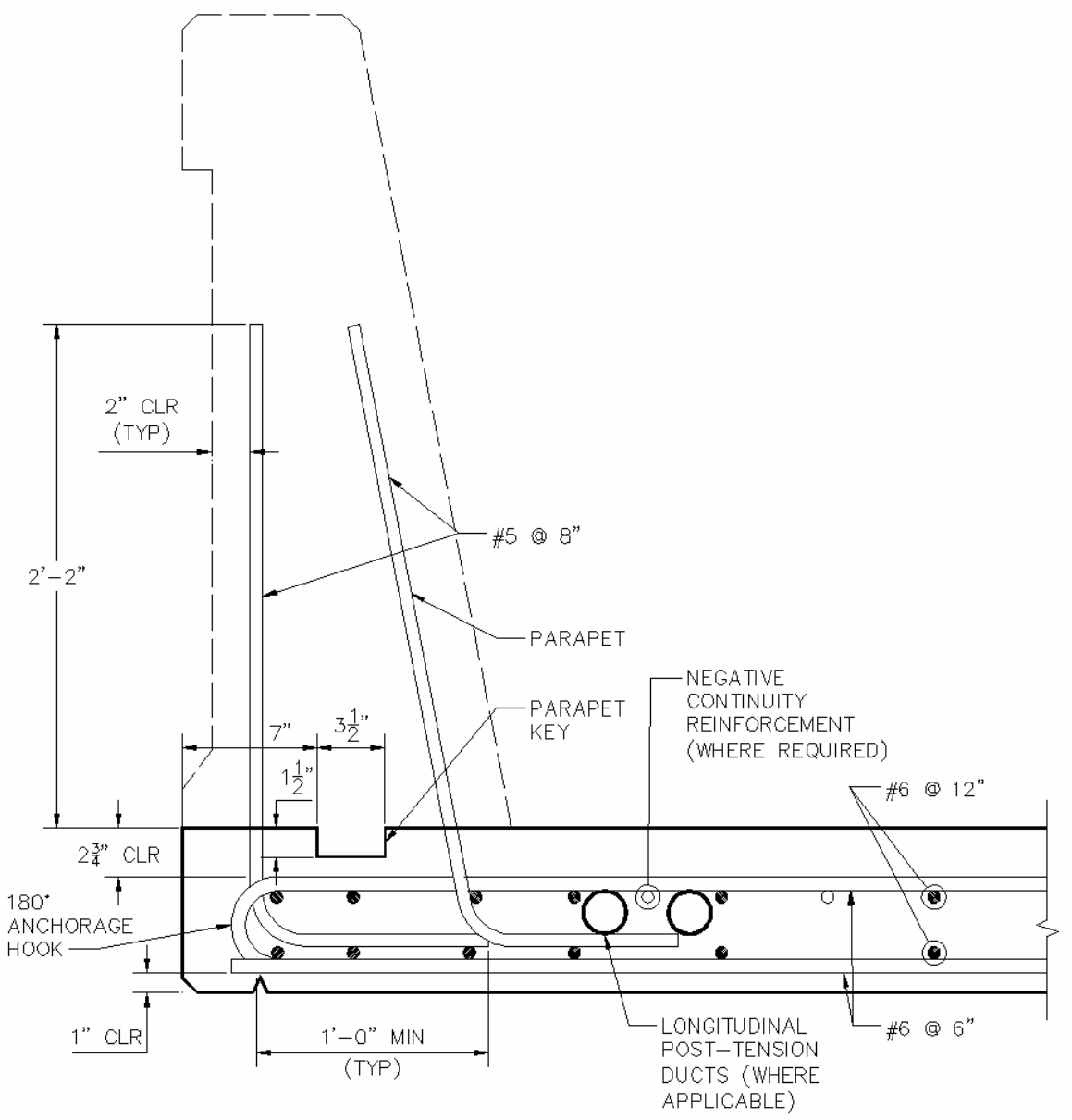

Figure 5 - Precast Panel

Prestressed Concrete Panel
Recommended Bar Sizes and Maximum Spacing

The information in this section shows typical precast prestressed concrete panel reinforcing and its placement. The reinforcement sizes, bends, and locations may be different from that given due to design requirements. Place all reinforcement in two layers. See standard drawings for reinforcement sizes and typical spacing.

Contractor and manufacturer are responsible for verifying that provided reinforcement will suffice for proprietary systems.

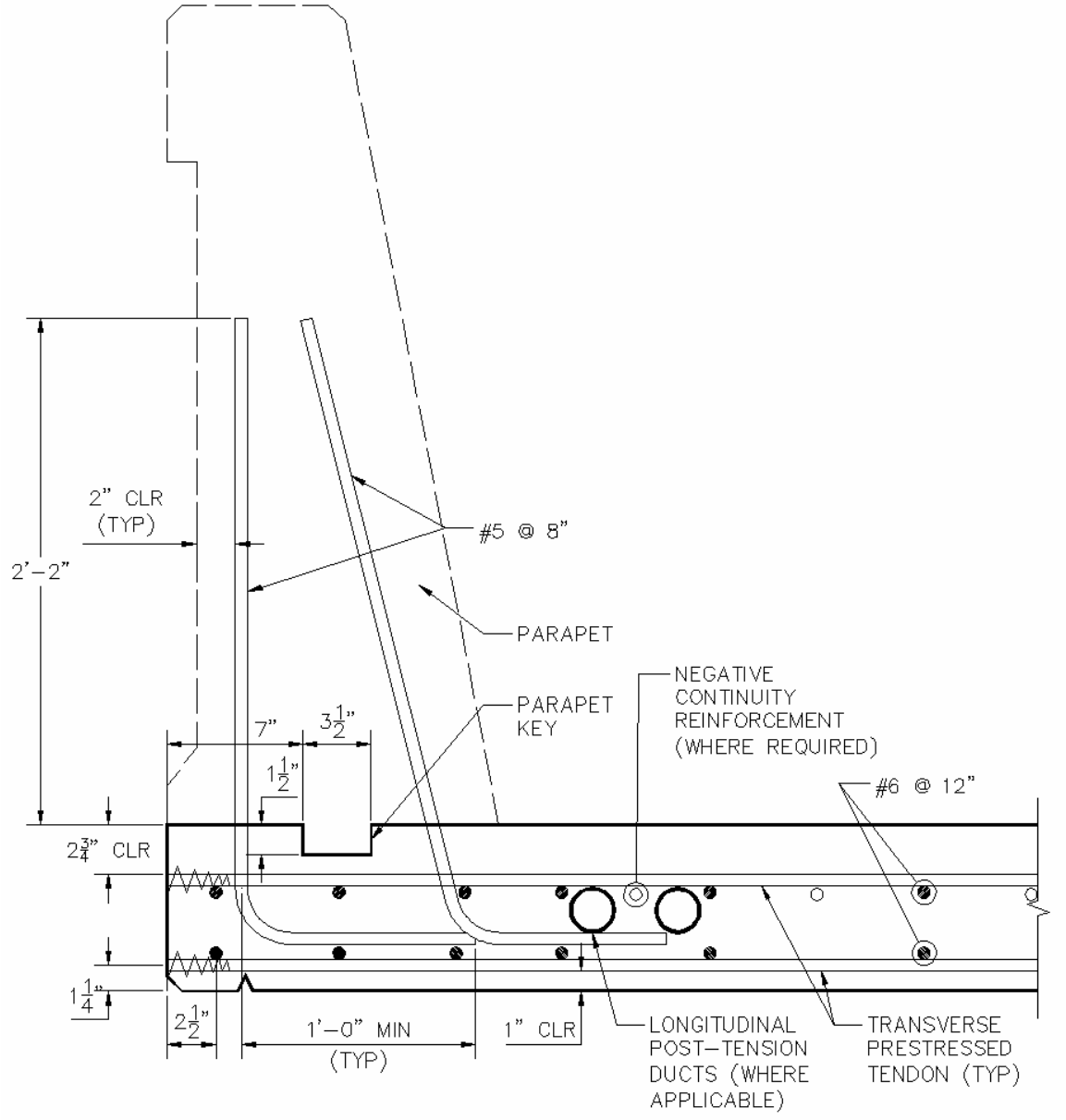

Figure 6 - Prestressed Panel

Section 7

HORIZONTAL SHEAR CONNECTION TO BEAMS / GIRDERS

Shear connections via blockouts

Design Engineer will determine shear connectors and spacing. Evaluate Post-Tension effects, if applicable, on superstructure.

One of two methods will accomplish shear connection to the concrete beams or steel girders:

1. Use stirrups or shear studs.
2. T-Headed reinforcing bars.

Deck Replacement

- Contractor will remove existing shear reinforcement or studs without damaging the beam or girder and leave less than 1/2" material above top of flange.

New Construction

- Use stirrups or embedded T-Headed reinforcing bars in concrete new construction.
- Use welded shear studs for new steel girder construction.

T-Headed Reinforcing Bars into Existing or New Concrete Beams

- In new construction, cast-in-place stirrups or T-headed reinforcement
- #6 reinforcement or equivalent.
- Head size will be designed to fully develop bar.
- Bar will be embedded into concrete beam at least 6-5/8” and provide at least 26.4 kips in tension.
- Contractor will use an approved anchorage epoxy and follow all of the recommendations of the epoxy manufacturer.

Welded Shear Stud Connectors on Steel Girder

- Shear connectors will be at least 3/4” in diameter.
- Length of required shaft will be determined by two factors:
    - The bottom of head of the connector will be at or above mid-height of panel but will maintain 3” of clear cover.
    - Length will be at least four times the diameter.
- Attach the connector to the steel flange by an approved method.
- Testing of shear connectors will be by approved methods and verified prior to placement of panels.

Section 8

LIFTING DEVICES, HANDLING, AND STORAGE

Steel lifting devices

Contractor will provide the spacing and location of the lifting devices and submit plan and handling stress calculations to the Engineer for approval prior to construction of panel. See Specification 03339 for Handling Stress Requirements.

Place lifting devices no closer that 2’-0” from the edge of the panels.

Place additional reinforcement on each side of the lifting device and in each direction of the panel to distribute the load. Place the additional reinforcement below the first layer of panel reinforcement. The lifting device will have positive connection to this additional reinforcement.

Install devices per the manufacture’s instructions such that the remaining member after placement is at least 1/2" below the finished surface of the panel.

Lifting devices will be either removable below the top surface of the panel after placement. Any divot or void at the lifting devices will have a heavy broom finish. After placement of panel in final position, fill divots or voids in with structural non-shrink grout. Place grout high and ground to final elevation.

Handling and Storage

Contractor is responsible for the handling and storage of panels in such a manner that does not cause undue stress on the panel. Submit a handling and storage plan to the Engineer for review prior to the construction of any panel.

The Engineer will inspect all panels and reject any defective panel. Replace any rejected panel at the contractor’s expense. Contractor will be responsible for any schedule delays due to rejected panels. Reject panels for the following but not limited to broken corners, full depth cracking, or significant dimensional deformities. See Specification 03339 for Handling and Storage.

Section 9

VERTICAL ADJUSTMENT

Vertical Adjustment Devices

Use vertical adjustment devices in conjunction with continuous removable camber strips to form 1-inch minimum haunch. Use vertical adjustment devices to maintain proper elevation of deck and slope. The device will consist of a cast-in-place barrel with a removable bolt or similar. Devices will be pre-adjusted to approximate required final elevation for panel.

There will be at least two devices per panel along each girder.

The portion of the device that contacts the beam, typically the bolt, will have a surface bearing area of at least $0.75in^2$ per device. During installation, all devices must be in full contact with the beams. Contractor will provide a bearing plate under each bolt. Contractor will also provide the type of connection of the bearing plate to the beam. Size the plate to distribute the applied over an area resulting in less stress than the 28-day compressive strength of the concrete.

Each adjustment device will have a capacity of at least one-third the total panel weight.

Make a 2" opening at the center of each beam or girder on one side of the camber strip. Once the panel has been set to the final elevation and fully tensioned, if applicable, pump non-shrink flowable grout in from each end and each shear stud blockout until the non-shrink grout flows from the center opening freely without major air pockets. Once allowed to cure, remove the camber strips and leveling bolts and inspect the non-shrink grout. Repair any voids per the non-shrink grout manufactures instructions. Fill the voids left by the bolts with the non-shrink flowable grout. Place the non-shrink grout high and ground to final elevation.

Designer will verify the type of device used and the locations of the devices. Show device locations on the plans.

Section 10

TRANSVERSE JOINT SHEAR CONNECTIONS

Shear Transfer at Transverse Joint

Base the selection of the transverse joint connection on several factors:

Connection Type	Bridge Type			
	Single Span			Multi Span
	Expected Life Span			
	≤ 10 Years	≤ 15 Years	> 15 years	All
Weld Tie	✓			
Shear Keyway	✓	✓		
LPT	✓	✓	✓	✓

Transverse joints tend to crack due to wheel loads, warping, and environmental effects, leading to leaking of the keys and decreased shear transfer. The relative movement between adjacent panels tends to crack the overlay, if present. Give special attention to the detailing, spacing and locations of the above shear transfer connections.

Grout the transverse joint components, block-outs, and post-tensioning ducts (if applicable) with a non-shrink grout having a minimum compressive strength of 5.0 ksi at 24 hours. Since reinforcement will pass through grout, the grout will have a corrosion inhibitor admixture to prolong the life of the reinforcement and the structure. Additionally, structural non-shrink grout in keys tend to rubblize over time due to the cyclical nature of bridge structures, synthetic fiber reinforcement will be included to give added strength to the non-shrink grout and to reduce the amount of micro-cracking.

All grout will be poured high and ground to elevation to prevent low areas.

Typically, for ease of fabrication, select panels with mild reinforcement for narrow girder spacing under 10’. Select prestressed panels for beam spacing greater than 10'. Furthermore, the prestressed panels may prove to be more durable and may be more economical in the long term. For expected life spans of 15 years and greater, the prestressed panel should be selected.

A transverse joint between the panels will create a maintenance point. The longitudinally post-tensioned panel is the preferred connection as it provides compression at the joint that helps resist cracking and water infiltration at the joint.

TRANSVERSE JOINT SHEAR CONNECTIONS (cont.)

Weld Tie*

** ONLY select the Weld Tie with written authorization from Utah Department of Transportation.* Letter of Authorization will be included with all plan set submittals.

The welded shear key is located at a maximum every 2'-0" and a maximum of 1'-3" from the edge of panel. Designer will verify that the 2'-0" maximum spacing is sufficient for the specific project. Weld plate and dowel will conform to ASTM A500 Gr. B or C, 46 to 50-ksi minimum yield stress.

The welded tie consists of a pair of 3"x6"x1/2" weld plate with two 1/2" diameter by 4" long shear studs cast into the shear key. A 6" long 1-1/4" diameter smooth dowel will be continuously field welded into place along both faces of the weld plate. Do not use mild reinforcement for the dowel. Use a smooth steel dowel with similar material as weld plate.

Visually test at least fifty percent (50%) of all welds. Randomly test 10% of remaining welds by approved non-destructive testing (NDT) methods. Repair any faulty welding by approved methods set forth by the Engineer. Test all welds using an approved NDT, if more than 40 percent (40%) of the randomly NDT tested welds are found to be faulty.

Grout keyways and blockouts with synthetic fiber reinforced non-shrink grout per Specification 03339.

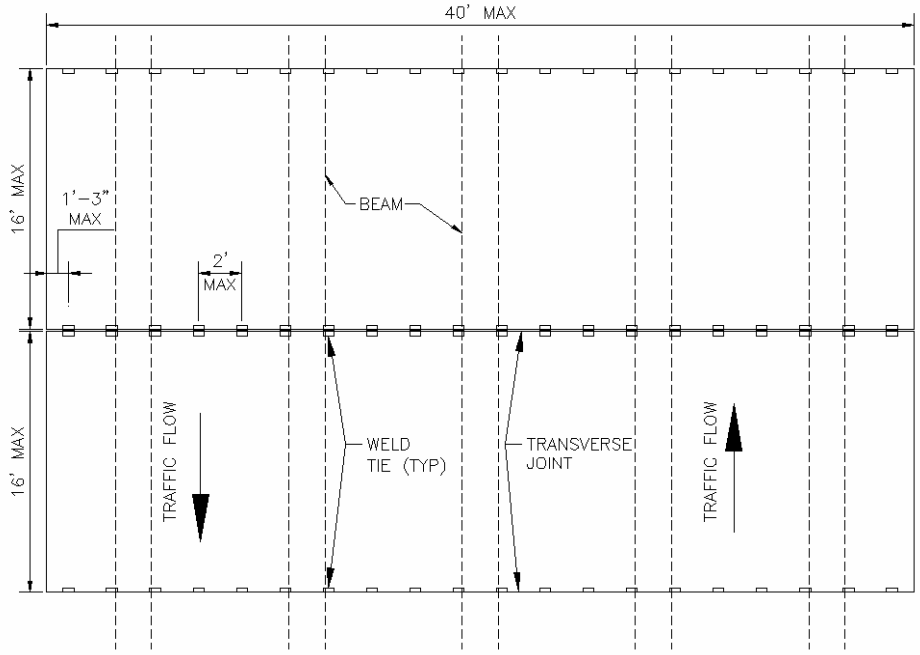

Figure 7 - Transverse Joint, Weld Tie

TRANSVERSE JOINT SHEAR CONNECTIONS (cont.)

Shear Keyway

The shear keyway is located at a maximum every 2'-0" and extends to a maximum of 1'-3" from the edge of panel.

The shear keyway consists of a Hollow Structural Member (HSS) 12x4x3/8 by 4" long conforming to ASTM A500 Gr. C. This member will be Hot Dipped Galvanized (HDG) after all modifications to the member are complete.

Place the HSS over the bottom layer of longitudinal reinforcement. Punch or drill a 1" diameter hole into the sidewall of the member allowing the top layer of reinforcement to enter the HSS member. Pass at least four top layer longitudinal reinforcement through the open ends of the HSS tube.

Cut a 1-1/2" wide cutout member top. Align the cutout with the longitudinal hole. Remove the cutout sidewall opposite the longitudinal hole and cut to the same depth of the hole. Place a hot dipped galvanized 2'-0" #6 splice bar with the longitudinal reinforcement of each panel.

Grout the joint with non-shrink grout per Specification 03339. Add synthetic fiber reinforcement to the grout.

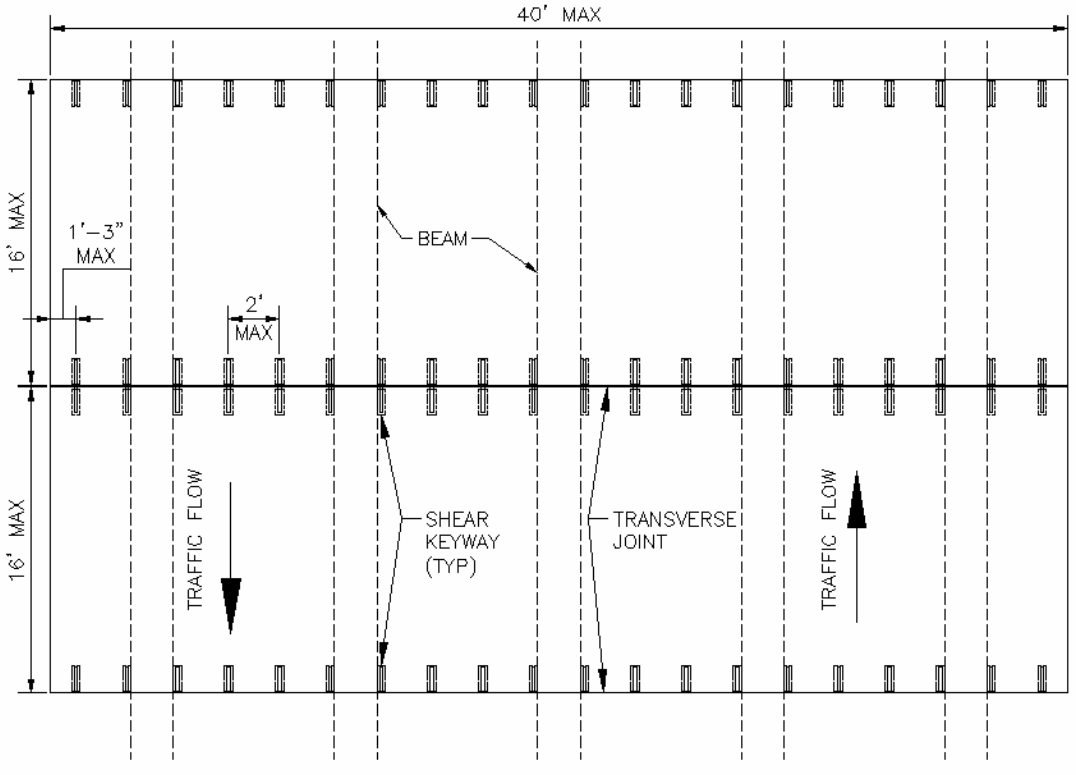

Figure 8 - Transverse Joint, Shear Keyway

TRANSVERSE JOINT SHEAR CONNECTIONS

Longitudinal Post-Tensioning (LPT)

Panels made flexurally continuous by longitudinal post-tensioning are the preferred transverse joint detail because they behave more monolithically and require less maintenance on the long-term basis. Use LPT on all multi-span bridges or bridges with a life expectancy of greater than 15 years. The post-tensioning ducts should be located at the center of the slab cross-section (center of gravity); variations due to location of mild-reinforcement or prestressing strands are acceptable. Provide block-outs in the joints to permit the splicing of post-tensioning ducts. The use of proprietary post-tensioning systems is acceptable provided average post-tension stress at the joint is achievable.

Place panels on the beams without mortar or adhesives to permit their movement relative to the beams during post-tensioning. Place panels directly on camber strips of inorganic material or other leveling devices. Grout the space between the beam and panel at the same time as the shear connector blockouts, after post-tension operations are complete.

This panel shear connection utilizes longitudinal post tensioning through the panel parallel to the beams and across the transverse joint. The LPT tendons are located at a maximum spacing every 6’-0” and a maximum distance of 3’-0” from the edge of panel. The designer will determine the spacing of these LPT connections to ensure an average post-tension stress of 300 psi at the face of the panel after accounting for all losses.

The LPT will consist of a minimum 1-3/8” diameter high strength threaded rod with an ultimate stress of at least 150 ksi and a 1-3/4” thick anchor plate at each end. The anchor plate will provide at least 50 square inches of surface area per tensioned rod.

Each anchor plate will support two (2) rod openings and will have three welded studs for positive connection to the concrete. The shear studs will be a minimum of 1/2” diameter by 4”. Place the end shear studs centered on the plate and at least 1-1/4” from each end. Place the third shear stud centered between the openings for the LPT and centered on the plate. End panel anchor plates may have single opening anchor plates with an area of 65 square inches. See LPT Detail Sheet for more information.

Place the manufacturer recommended duct longitudinally between the anchor plates. Place a temporary rod through the duct and plates to ensure correct positioning of the duct during forming of the concrete. Remove the temporary rods prior to shipping of panels. Refer to the UDOT Specification 03339.

Longitudinal Post-Tensioning (LPT) (cont.)

Place panels initially set to elevation. Grout shear keyways between post-tension blockouts. Post-tension the panels and confirm elevation. Check shear connections for location within blockouts and make any required modifications. Grout the post-tension rods and inspect per manufacture's instructions. Install shear studs. Grout the shear and post-tension blockouts and girder/panel interface with non-shrink grout per Specification 03339.

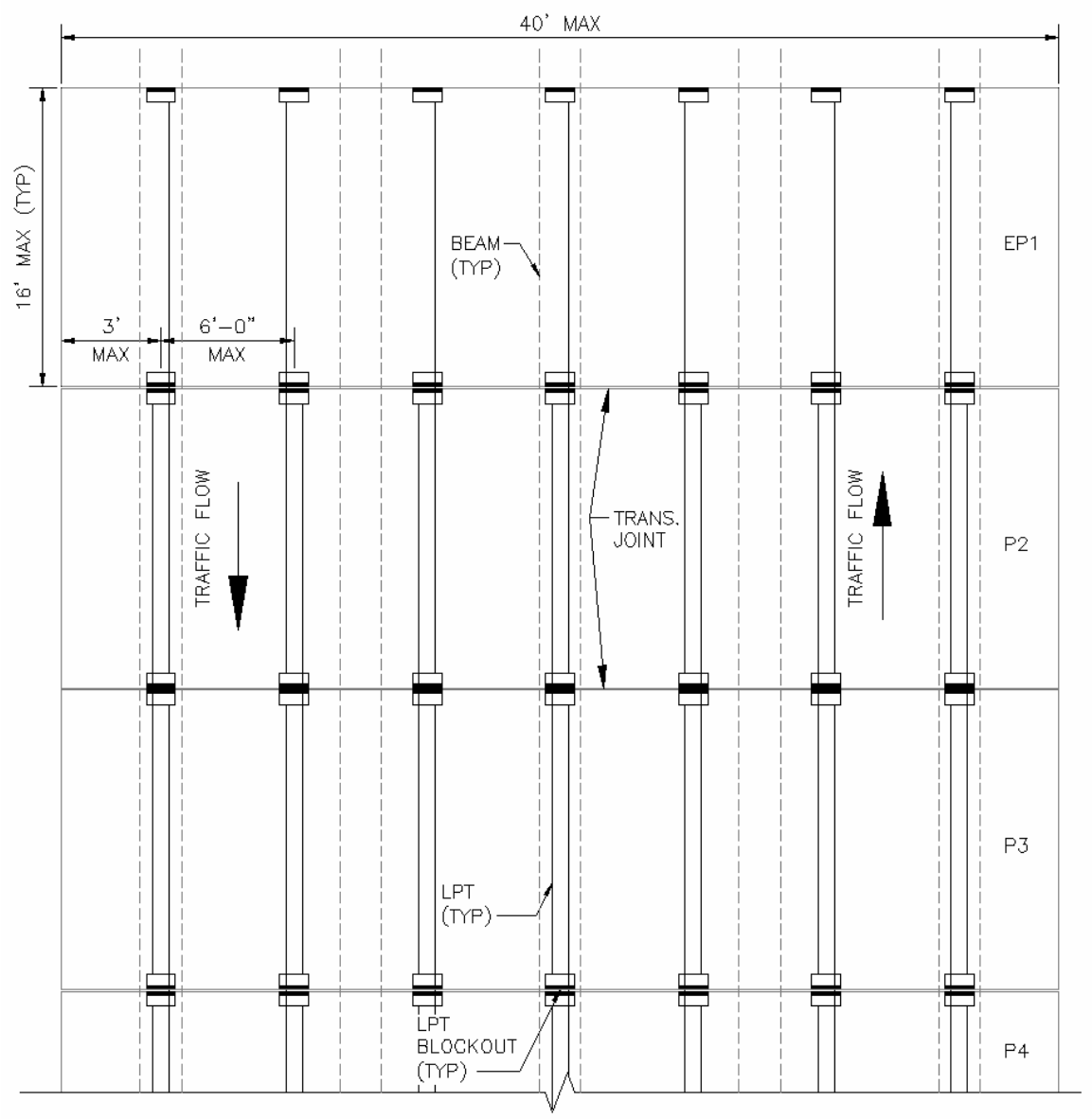

Figure 9 - Transverse Joint, LPT

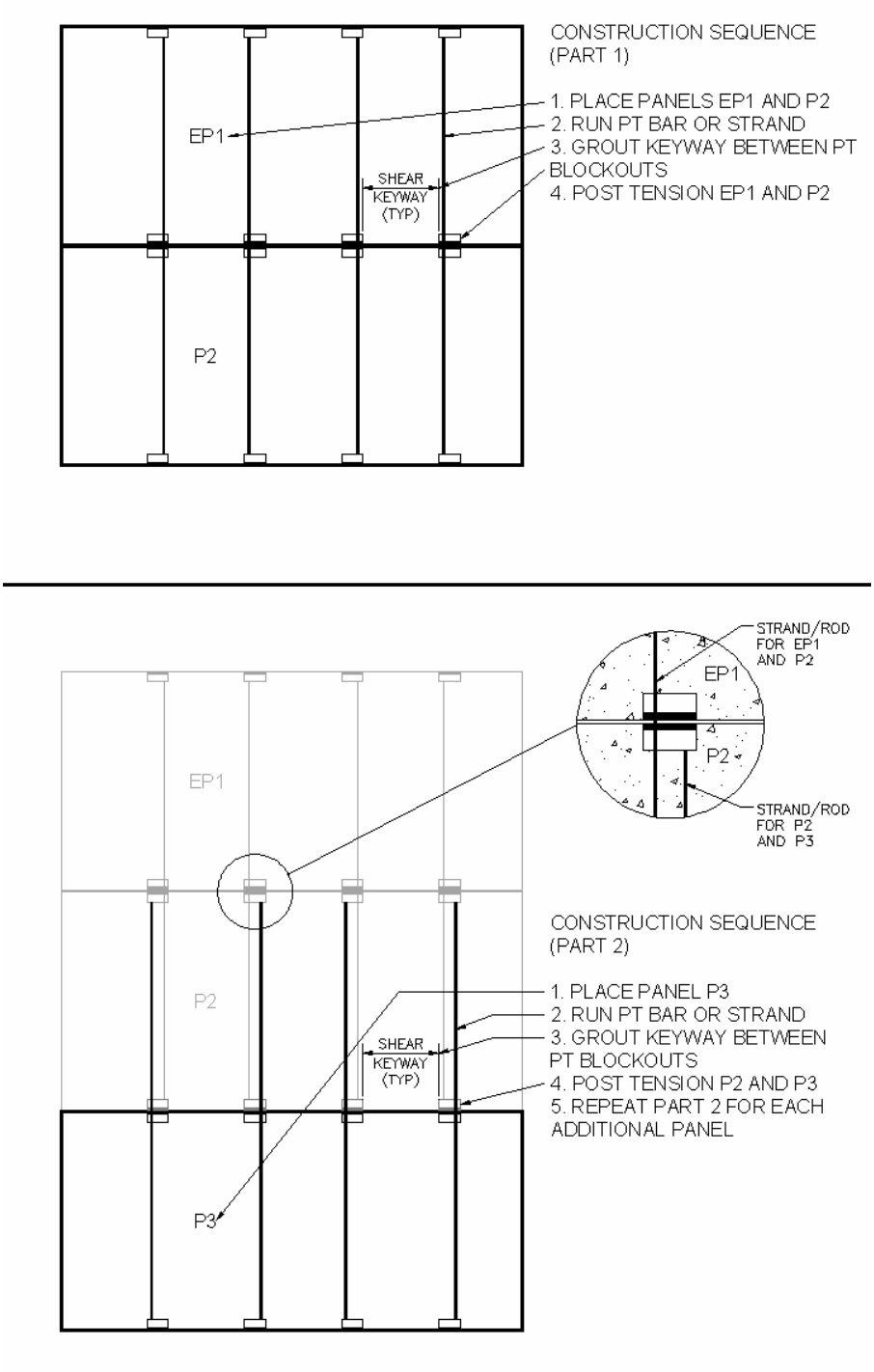

Figure 10 - LPT Construction Sequence

At designer or contractor's option, use 270-ksi low-relaxation strand in lieu of high-strength rod as described above for post-tensioning but design the connections to ensure a minimum of 300-psi average contact post-tension stress at the face of each panel. Stands, anchorages, and couplers will conform to the AASHTO LRFD Bridge Construction Specifications.

Section 11

TRANSVERSE PRESTRESSING

Materials

Concrete
- f'_{ci} = 4,000 psi
- f'_c = 5,000 psi

Prestressing Strand
- Low relaxation strand
- f_u = 270 ksi
- d_{ps} = 0.5 in
- A = 0.153 in^2

Designer may select a precast panel or prestressed panel when the spacing of the beams or girders is between 8’ and 10’. When the spacing is greater than 10’, the designer will use a prestressed panel. The prestressed panel may provide a more durable structure. Design will consider life span of structure and bridge configuration when selecting panel type. If life expectancy is greater than 25 years, give strong consideration to this option.

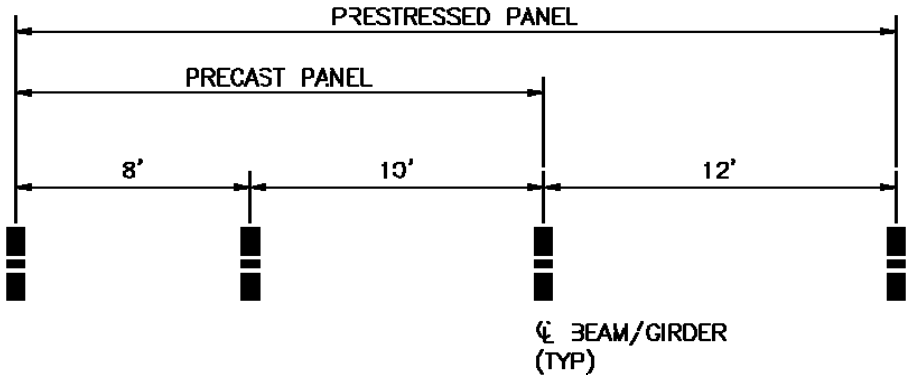

Figure 11 - Beam Spacing Panel Selection

The Prestressed Concrete Panel will be of nominal thickness with strands placed transversely and approximately level at a maximum spacing of 1’-0”. Place each strand as close to the extreme fiber as the clear cover will allow.

Designer will verify any required local anchorage or confinement mild reinforcement.

Section 12

THIN BONDED POLYMER OVERLAY

Materials

Thin Bonded Polymer Overlay will conform to Section 03372, Thin Bonded Polymer Overlay. Only use Epoxy-Urethane Co-Polymer, Type 1.

Application

All surfaces that are to receive an overlay will have a heavy broom finish.

Apply the overlay to the panel surface after the surface has been prepared to the manufacture's recommendation.

The designer will select an overlay thickness equal to or greater than 1/2" to increase durability and lifespan of panel, to resist the deicing chemicals, and reduce the amount of water infiltration into the weak transverse joint.

At minimum, apply the overlay in at least two coats to obtain the minimum required thickness.

Joints of the overlay will not coincide with the joints of the deck panels.

Section 13

CLOSURE POURS

General

Closure pours may be used were needed as directed, designed, and detailed by the designer. Concrete compressive strength will be of at least 4000 psi and will include a corrosion inhibitor. Provided details are for beam spacing up to 10'. Designer will design and detail closure pour for beam spacing larger beam spacing.

Cast-in-place closure pours tend to behave differently then precast or prestressed panels. This is due to multiple factors. The panels will typically have better casting environments and more controlled conditions of a cast-in-place structure. Designer should include synthetic fiber reinforcement to increase the longevity of the closure pours.

When required, use mechanical couplers in conjunction with the continuous panel reinforcement to provide continuous reinforcement in closure pour. All mechanical couplers will conform to AASHTO 5.11.5.2.2 and ACI 318 12.15.3 and meet UDOT requirements. If used, precast the couplers into the panel after securely attaching them to the continuous reinforcement.

Lap splices of continuous panel reinforcement made in a closure pour will be a minimum of 3'-1".

When girder spacing exceeds 7'-0", contractor will supply full-length temporary support to the panel overhang and closure pour until closure pour has gained full compressive strength.

Closures at Transverse Joint

The designer will include an 'edge beam' parallel to the transverse joint which will include at least three (3) #6, top and bottom, spaced at 3" for the full length of the transverse joint. Lap splices will be staggered so that no lap is adjacent, above, or below another lap splice. See Section A-A of Precast Panel Reinforcement Sheet for details.

Bridge Widening or Partial Deck Replacement

Contractor will cut back the existing deck to the next available beam or girders, leaving enough of the existing reinforcing to provide proper lap splices from the panel, clean the reinforcement, and repair any damaged coating per UDOT specifications.

The panel will cover at least two full bays, be in full contact and provide shear connections at least two beams or girders, and have bearing on a third beam or girder.

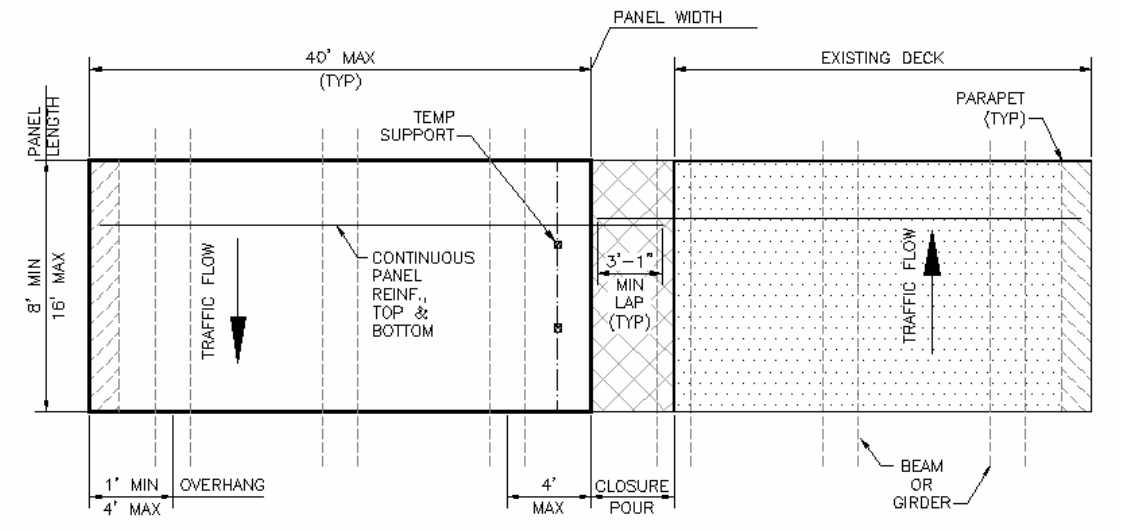

Figure 12 - Deck Widening or Partial Deck Replacement

Bridge Deck Wider than 40'-0"

If a panel is not wide enough for an entire bridge width, greater than 40'-0", use at least two panels with a longitudinal closure pour between. The closure pour will occur within the bay of the beams or girders. All panels will have a minimum of 1'-0" overhang with the exception of a closure pour location.

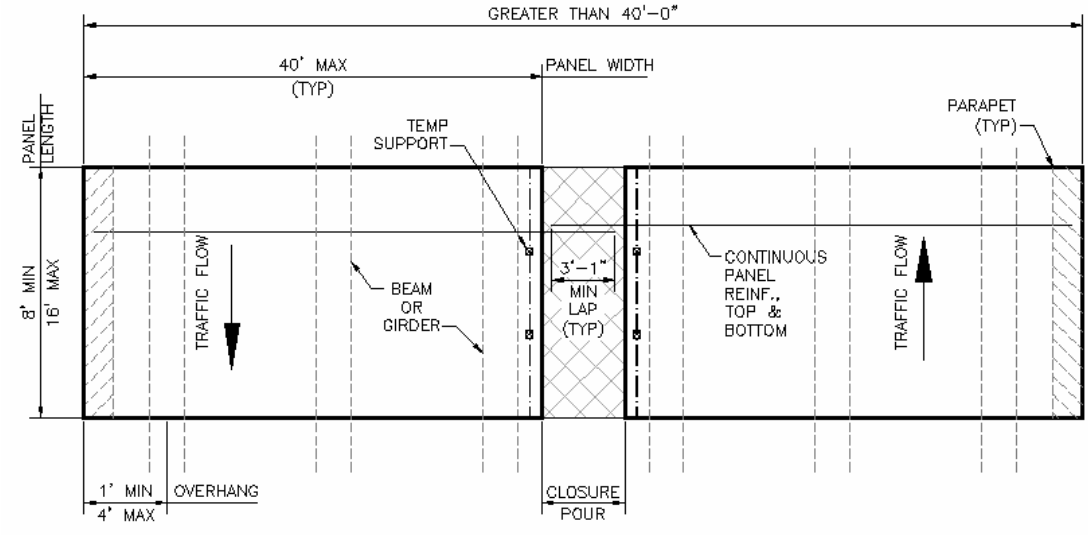

Figure 13 - Panel-to-Panel w/ Closure Pour